IN TOUCH WITH CHINA'S SCHOLARS

SUPPLEMENT

By
WM. WILSON, M.B., C.M.
WITH PREFACE BY
JOHN R. MOTT, M.A.

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CONTAINING :

Details of a somewhat scientific and technical character which for the sake of the general reader have been deliberately excluded from the body of the booklet, but being at the same time such as may appeal strongly to some minds as of special interest have been collected into a separate section and thus appear in the form of a Supplement.

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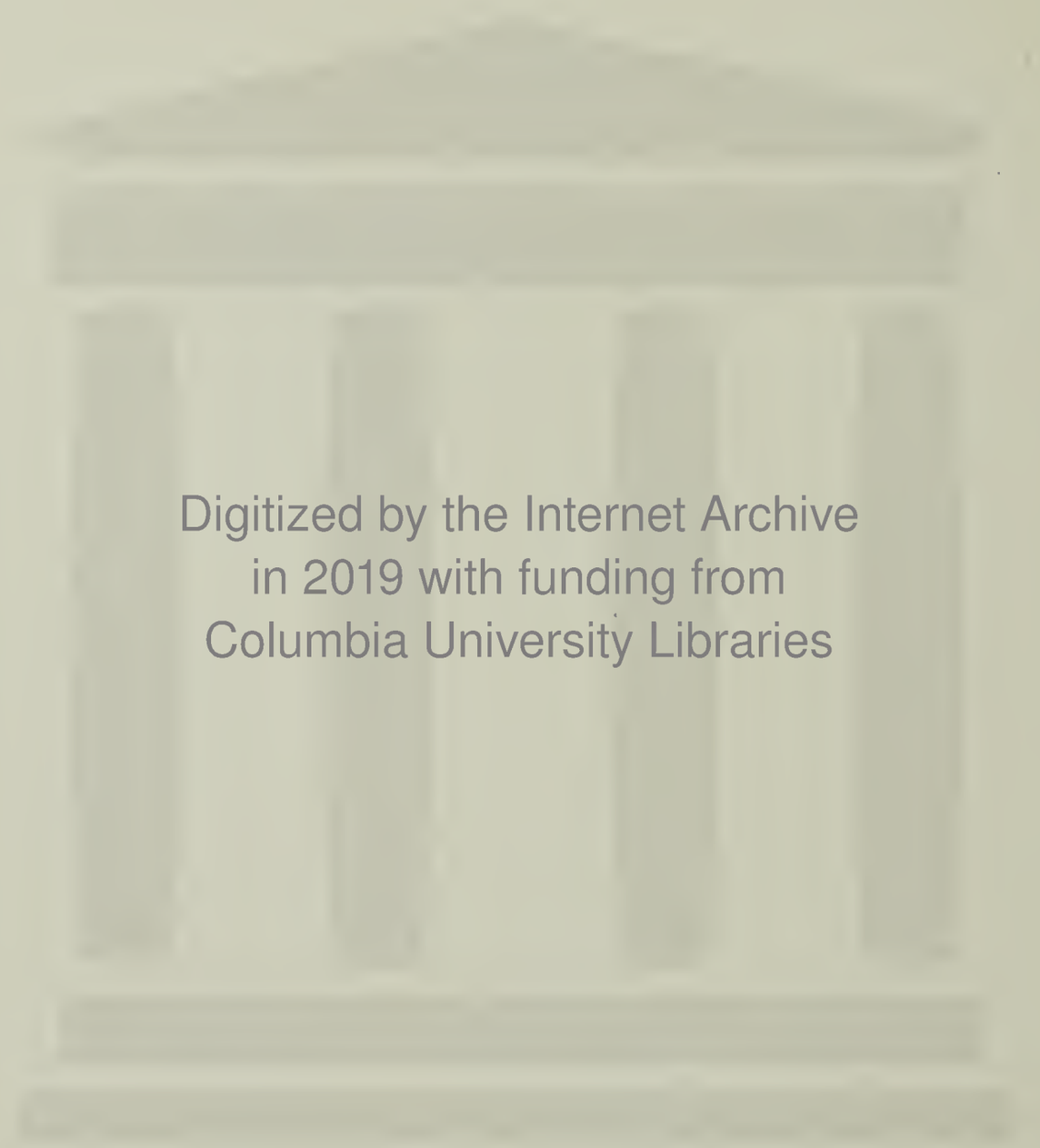


PREFACE.

BY

JOHN R. MOTT, M.A.

FOR two thousand years the literati have wielded larger influence in China than in any other nation. They continue to dominate that land of largest possibilities in Asia. The stupendous educational changes now in progress there increase, rather than diminish, the importance of the educated classes in China, because the first generation of modern Chinese students will, more than any other one factor, determine the character of the New China. Until recently the educated classes have been comparatively unreached by Christianity. The methods employed by Dr. Wilson afford favorable access to these future leaders. It would be difficult to overstate the possibilities of the new work he contemplates, now that it is affiliated with the Young Men's Christian Association—a movement which has demonstrated such marked ability to reach, for Christ and the Church, the students of the non-Christian world.

CORRECTION: On page 23, line 5, for "New York Committee" read "International Committee."

SCIENCE HALL—INTERIOR.

This building is 50 ft. long by 30 ft. wide, with gallery all round. It is shown as seated for students, with lecture table covered with electrical apparatus. Apparatus in the centre of the table represents three systems of telegraphy (to the left) Wheatstone's Needle Instrument; (to the right) a Sounder Instrument; (below) a Morse Inker; (in the middle) a 3-way switch for putting any of these into action.

ONE OF THE EARLIEST STUDENTS AND HIS COLLECTION OF APPARATUS.

(Some, merely for effect, are represented in multiple.)

SUPPLEMENT.

THE work described in the booklet, to which the following pages form a supplement, has had for its object the obtaining a friendly intercourse with the Literati or educated class in China, so that, with the removal thereby of ignorant prejudice, the way might be prepared for the advance of missionary work among this important section of the community.

The newly aroused thirst for Western knowledge seemed to indicate the road by which this friendly intercourse might be obtained, and the institution of courses of lectures on scientific subjects to supply the key by which this door of access might be opened.

The work developed along these lines thus came to comprise the following features:—The delivery of elementary lectures on science, the institution of a museum of apparatus and models, and the establishment of a workshop, where the students were encouraged and helped to make their own apparatus.

In a description of such work it is obviously impossible to eliminate all reference to technical subjects, names of apparatus and instruments, methods of construction, etc., etc.

Yet the undue intrusion of such details would, to the general reader, detract from, rather than increase, his or her interest and pleasure in the perusal of such a record.

But, on the other hand, there is a large and increasing number of persons, who, while primarily deeply interested in all missionary work, would feel a special interest in any effort designed to reach the educated class, and the very fact, in many cases, that they are themselves interested in, and, perhaps, personally occupied with, matters of an educational and scientific character would lead them to regard with real sympathetic interest every detail that they could gather with regard to such work.

To such readers the deliberate avoidance of all such technical detail from the record would not be regarded in the least as a recommendation, but, rather, as a distinct loss and disappointment.

The aim has, accordingly, been to meet the requirements of these two classes of readers. The general reader will be able to peruse the booklet without the distraction due to the intrusion of technical details which do not specially appeal to him, while in the case of others the perusal of the booklet and the general account therein contained may with interest and advantage be followed by the reading of the more detailed and technical matter contained in this supplement.

The subjects referred to in the following pages may be conveniently divided into three sections:—First, the Lectures and their Scope; second, the Museum and its Contents; and third, the Workshop and its Methods.

The Lectures and their Scope.

THE particular branches of science which have in the main formed the subject matter of the lectures have been Chemistry and Electricity, and to a less extent Hydrostatics, Pneumatics, Heat and Steam. Several considerations had their influence in this selection of subjects.

Among the educated Chinese, although little may be known of any science except the name, there is a general impression that of all the physical sciences the most important are Chemistry and Electricity, and, consequently, their desire to understand these subjects is proportionately great, and to lecture on such matters would specially appeal to them.

Again, the apparatus necessary to illustrate the lectures is more easily prepared in the case of these two subjects than in the case of others.

As regards Chemistry, most of the chemicals required were to be found in the dispensary already constituting an integral part of the Mission station, and in the preparation of apparatus a few flasks and glass and india-rubber tubing go a long way.

The same applies, though to a less extent, in the case of apparatus for illustrating lectures on Electricity and Magnetism. Quite a large number of pieces of apparatus can be prepared without the necessity for good lathes or other tools of precision, and using only the common materials everywhere obtainable and workmanship of only average quality.

In a six weeks' course of 36 lectures the plan usually was to devote 15 lectures to Chemistry and 15 to Electricity, and the remaining six were apportioned to such subjects as Hydrostatics, Pneumatics, Heat and Steam; and this only so far as to enable the students to understand some of the more obvious practical applications of these sciences.

While space forbids any attempt to give a synopsis of the lectures on Chemistry and Electricity, a few words may not be out of place as illustrating the general line taken in connection with those subjects which were treated of more briefly:

Lecture 1.—Pneumatics.

Illustrated by the diving bell, of which a model was arranged capable of being raised and lowered by a crane, lit up inside with electric light, and, of course, supplied with air by a tube from an imaginary pumping engine.

Lecture 2.—Pneumatics (*continued*).

Illustrated by the Forth Bridge, of which a drawing was shown and a description given as to its size and general method of construction, and then most of the lecture was devoted to a series of models illustrating the method of sinking the giant cylinders, and excavating for and building the foundations far below the water level and far below the river bed. All these operations, it was explained, necessitated the adoption of the plan of working with a high air pressure within the cylinders and the employment of the air-lock by which men and material could pass to and fro between the ordinary atmospheric pressure outside and the high pressure in the cylinder.

Lecture 3.—Heat.

Artificial ways of producing heat and cold. Ice made before the students by the evaporation of ether spray. Experiments to prove that solids, liquids and gases expand by heat and contract by cold and the many practical applications of these facts.

Lecture 4.—Hydrostatics.

Suction pump, force pump and fire engine—the last two illustrated by working models which acted perfectly, and in the construction of which the only things used were two glass syringes, an empty bottle (for the air chamber), india-rubber tubing, glass tubing, corks, india-rubber for valves, and the expenditure of about three hours' time.

Lecture 5.—Hydrostatics (*continued*).

Hydraulic press, illustrated by a model, and then a description of how Robert Stephenson raised the tubes of the Menai Straits Tubular Bridge by means of two hydraulic presses, one standing on the top of each masonry pier, 130 ft. above the water level, each ram carrying an iron beam, from the ends of which hung chains by which the tubes were suspended. Each tube thus raised measuring 460 ft. long and weighing 1,500 tons.

Lecture 6.—Steam.

The boiling point of various liquids and their variation according to altitude above or below sea level. The relative volume of water and the same converted into steam. The construction of a steam boiler (illustrated by a model). Steam pressure shown by its power to balance a column of water or mercury. Vacuum produced by condensation of steam and its influence in the action of low pressure engine. Detail description from a model of the construction and action of an ordinary steam engine and also of a turbine steam engine.

2. The Museum and its Contents.

AS regards the contents of the Museum the interest centres, not so much in the number and quality of the pieces of apparatus gradually accumulated, as in the fact that with very few exceptions they have all been made in the place, and that place 1,500 miles from the coast—a far inland city in China.

When the writer returned to China seven years ago it was with no expectation of doing any work of this kind, nor, indeed, of doing anything in the way of educational work, but simply the further prosecution of the two-fold work of preaching the Gospel and healing the sick, which as a medical missionary had occupied him during the previous 18 years.

When the circumstances led to the commencing of this student work, the fact that no apparatus was available suggested the advisability of proceeding at once to make what was required rather than delay seven or eight months till such ordered from home could reach us in the interior,

Three Chinese artisans were engaged—a joiner, a blacksmith and a tinsmith—and though not one of these men had ever seen any scientific apparatus they simply worked to instructions and sketches given and accomplished their part of the work very well indeed.

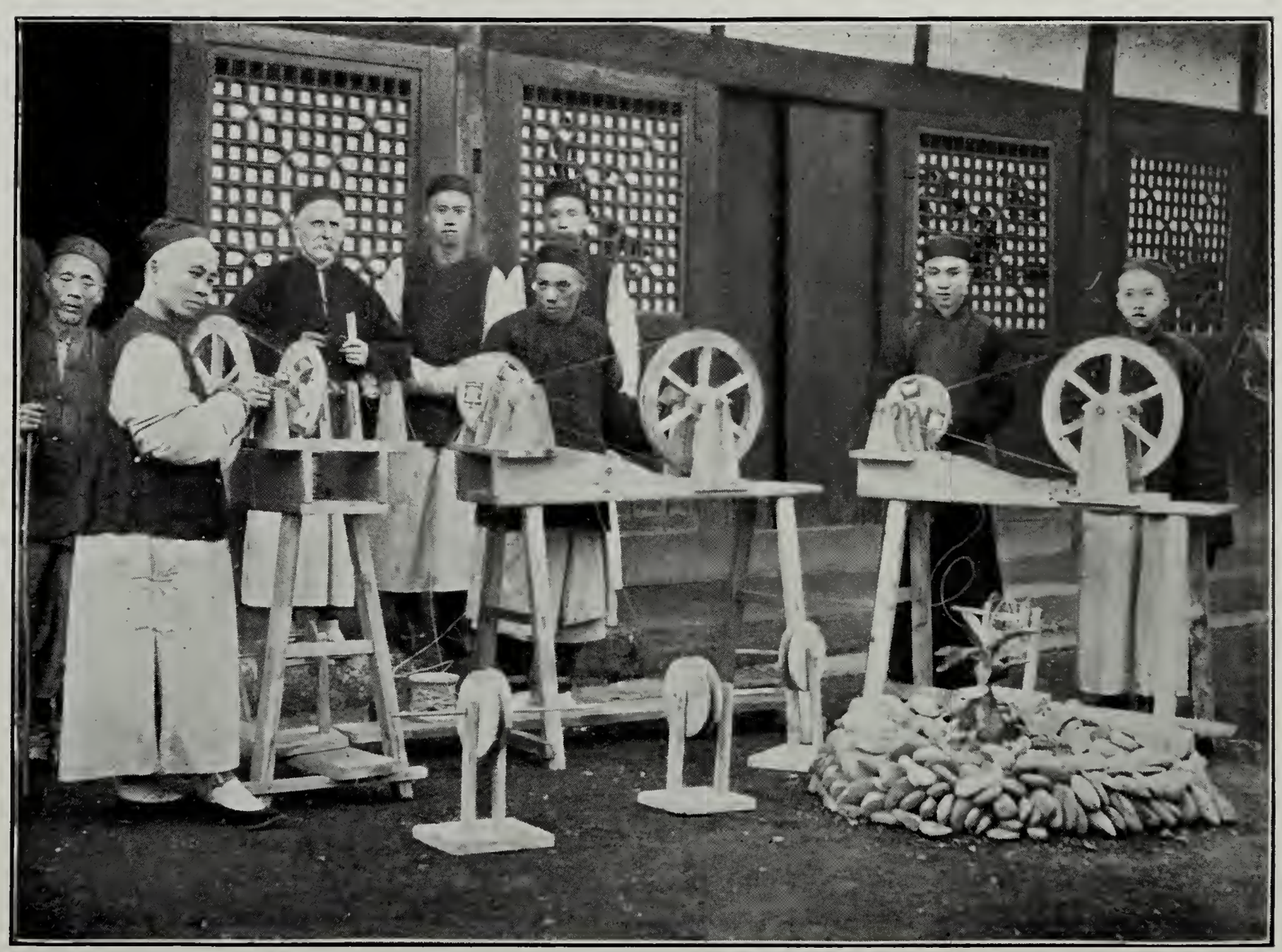
From the city of Chungking, eight days distant, copper wire could be obtained drawn to any gauge required, and after some simple machines had been made for covering this wire with cotton, and two boys had acquired proficiency in working the machines, we were quite independent of outside sources as regards this *sine quâ non* of electrical apparatus, insulated wire (except the finest gauge such as was used for secondary coils and telephones ; this we had to buy from England).

These two boys (quondam patients) covered in all over ten miles, their piece-work wages for the same amounting to about a penny for 100 feet ; and yet out of this they were able to pay for their board and make quite a little fortune ere they returned to their homes.

The construction of this machine for insulating the wire can be seen from the print, where a disc carrying a reel of cotton thread is made by means of a driving wheel and belt to revolve on its own axis ; this axis is hollow and permits of the wire being slowly drawn through. When first made and used care was exercised to maintain an exact relation between the speed at which the driving wheel was worked by the one hand and the wire drawn through by the other. Subsequently it was found by the boys during the working of the machine that, provided a right

THREE CHINESE ARTISANS.

A Joiner, Blacksmith and Tinsmith doing the preliminary work for the making of apparatus by the students.



MACHINES FOR INSULATING COPPER WIRE.

Three of these machines were made for the covering of copper wire with cotton. If the right tension is maintained in the cotton thread the wire comes through automatically, and the worker has nothing to do but turn the driving wheel as fast as he likes.

A Corner of the Hospital Courtyard.

The rooms at the far end were often occupied by students (when the number of patients permitted), subsequently the Temple, whose ornamental façade is seen to the left, was rented, and its extensive galleries divided up with temporary partitions into rooms for the accommodation of students.

STUDENTS SIMULTANEOUSLY PREPARING APPARATUS.

Eight students (in the back row), assisted by eight hospital patients or others winding insulated wire on to reels, etc., for Electro Magnets, Galvanometers, Telephones, Secondary Coils, etc.

tension on the cotton thread was maintained, the wire came through of its own accord and of course at the right speed, so running the wheel as fast as they could was all they had to mind about—all else was automatic.

Having thus seen how the stock of models and apparatus was produced from native material and by native workmanship it may be of some interest to append a list of the things thus made.

Commencing with models—these were mostly made of wood and tin suitably painted so as to represent stone, brick, earth, iron, wood, etc.

The principal objects represented were as follows : The Menai Straits Tubular Bridge, with additional models to show the section of the main tubes and the method employed in raising them from the water level up to their final destination, 130 feet above water. The Tower Bridge : A working model of a Swing Bridge. An ordinary Horizontal Stationary Engine : in which half the cylinder is removable, thus showing the relative movements of the piston and slide valves, opening and closing steam ports, etc. A model of a Gas Works Plant, showing retorts, retort house and furnaces, hydraulic main, scrubbers, purifiers and gasometer.

Electrical Apparatus comprise the following :

Static Electricity :—Electric pendulum, gold leaf electroscope, electrophorus, Cylinder Frictional Machine, Wimshurst and Voss Influence Machine, Leyden jars, Epinus' condenser, Apparatus to demonstrate Surface Distribution of Electricity.

Dynamic Electricity :—Batteries : Daniels', Groves', Bunsen, Bichromate, Leclanché, Telegraph Instruments, Wheatstone's Needle instrument, Morse inker electric bell, Wireless Telegraphy, Marconi and Castelli coherers, telephone, microphone, copper helix, Electro Magnet, Electro Magnetic Engine, Time Ball, Apparatus for Electrolysis of Water, Induction Coil and Electric Light.

Hydrostatic Apparatus :—Barker's Mill, Heros Fountain, Suction and Force Pump, Fire Engine and Hydraulic Press.

Heat :—Expansion by heat and contraction by cold of gases, liquids and solids. Linear expansion and spherical expansion of metals.

Chemical Apparatus :—Apparatus for the manufacture of and experiments with Oxygen, Hydrogen, Nitrogen, Chlorine, Carbonic Dioxide, etc.

An apparatus to demonstrate the indestructibility of matter by the burning of a candle previously weighed and collection of the products of combustion.

3. The Workshop and its Methods.

WHILE the apparatus above enumerated proved of great value in the elucidation of the lectures, it may without hesitation be said that the students learnt as much from the time spent in the workshop, making and fitting together their own apparatus, as from the time spent in listening to these systematic lectures.

It may not, therefore, be without interest to take a glimpse into the workshop and there see how they are occupied.

The students worked very well, the desire for scientific knowledge and apparatus completely overcoming their Confucian prejudices that it is beneath their dignity as educated men to engage in any kind of manual labour, and any day during the six weeks' course you might see the workshop well filled with eager students, some at the vice filing iron or steel, others burnishing copper or brass, some sawing up carbon preparatory to making the pencil microphone of the telephone transmitter, the hospital courtyard the meanwhile enlivened by the whirr of three machines where students are busy covering their copper wire. Another group might be seen gathered round a table where either the writer or his assistant would be helping each in turn with the final fitting together of the various parts of their pieces of apparatus. Just outside the workshop the tinsmith is the centre of a group of students eagerly watching him as he converts old clock springs into very delicately poised compass needles, over 150 of which are required for a batch of 30 students. These the students take into the workshop and there learn how, by a few strokes across the poles of an electric magnet, they can be magnetised and become magnetic needles.

Here is a student busy making a galvanometer, while the ringing sound of an electric bell in the next room tells you that another has just finished his bell, and in the battery room is testing its efficiency, while yet another may be seen with his just completed electro magnet, well pleased when he finds it easily holds up the required 4 lb. weight. Another is proving the efficacy of his telephone, or with a microphone just completed, is demonstrating the ticking of a watch 50 yards away.

As time went on and the students increased in number we gradually added also to the number of pieces of apparatus that each one was helped to make, and with more commodious workshops the work was capable of being systematised, so that each succeeding day a new piece of apparatus was taken in hand. Its purpose and use were explained, its construction made clear, and its action practically demonstrated before the class; then

each student was supplied with the various parts in an unfinished condition and the work of preparing the parts and fitting them together was simultaneously proeeeded with by each member of the class.

As in most pieees of eleetrieal apparatus eoils of insulated wire of some form were required, an arrangement was made for faeilitating sueh work.

One of the illustrations shows a row of eight students faeing the reader, and faeing them another row of eight helpers. Between the two rows is a long beam of wood, supported on legs at its two ends and fitted with eight poekets; into these by pin and eotter can be fixed eight winders; these sets of winders differ in form, one set of eight is made for reeeiving the reels for large eleetro magnets, another set the reels for smaller magnets, others for the galvanometer frame, while others again are suited for winding the small reels for Bell's telephone, while some again are suited for winding the seeondaries for small induetion eoils.

In this way eight men at a time can all be engaged doing similar work, and eaeh day a different elass of work, telephones, galvanometers, seeondary coils, reels for large magnets and small, or Wheatstone's needle instruments.

It will be observed that most of the eleetrieal instruments already enumerated are eoneerned with dynamie eleetrieity. This arose to some extent from the diffieulty of making a really effieient statie electrieal machine, and without sueh a generator of statie eleetricity, it was useless for the students to make other apparatus to be worked from a statie maehine.

Eventually sueeess erowned the efforts long persisted in, and an effieient Wimshurst influence machine was produeed.

The great diffieulty was from the fact that the Chinese in the interior have no lathes worthy of the name, though they have a very elumsy kind of lathe worked by the feet, with two treadles alternately, and thus producing a baekward and forward motion. Henee the diffieulty in turning the wooden bosses for the revolving plates with suffieient aeeuraey to permit of even revolution of the glass plates.

Again, the turning of an iron or steel spindle, and the aeurate fitting of the brass bushes was more than native applianees were eapable of, and eonsequently these parts had to be obtained from Shanghai. Ultimately, however, this diffieulty was solved by making Voss maehines instead of Wimshurst's, for with only one revolving plate and one stationary, a wooden boss and spindle could all be turned out of one piece of wood, and thus the need of a metal spindle was avoided.

A Chinese lapidary was found who, with the very simplest applianees, is able to cut the eireular glass plates to the required dimensions, and to make the eireular eentral hole of any needed size.

The lapidary's bench and complete outfit would not cost a couple of shillings, and consists of a table at which he sits, a few inches above the table is a horizontal iron spindle, rapidly revolving with a backward and forward motion, being worked by a strap wound round it and attached by its two ends to treadles under the table worked by his feet.

On the free end of the spindle is fixed a tin wheel, which, in the presence of finely powdered hard quartz and mixed with water, rapidly cuts its way through the glass plates held up gently against the revolving wheel.

Such a man, whose daily wages only amount to 3d., can with ease prepare 10 to 15 plates a day, and as all other expenses are in proportion it is not surprising that a Wimshurst influence machine with 12 in. diameter plates can be made for five shillings against 50 shillings if purchased in England.

One other useful occupation may be mentioned in which all the students were encouraged to engage, namely the preparation of diagrams.

Most of the students were already teachers in private schools, and regarded their study of science as a preparation for a wider sphere in connection with the newly opened Imperial Schools.

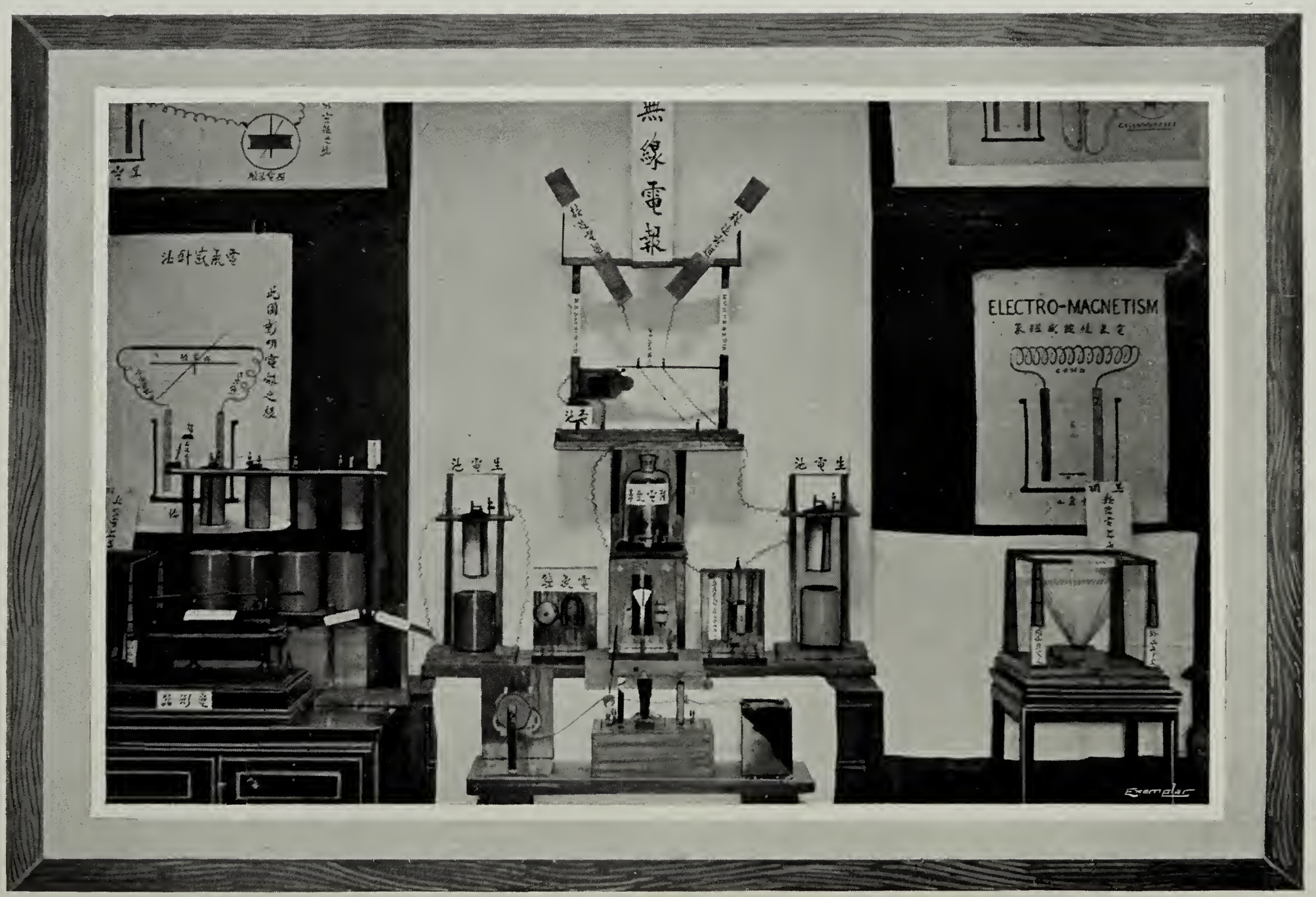
Having themselves acquired their rudimentary acquaintance with these subjects through the combined influence of the spoken voice, the illustrative diagram and the experimental use of apparatus, they at once saw the advisability of possessing all the diagrams they could.

In some cases these were traced through on tracing paper (Chinese window paper), or when men possessed some idea of drawing they would copy the diagrams on a smaller scale and even make them directly from models or pieces of apparatus.

In conclusion, it may possibly be of interest to some to glance at the following table, showing the various instruments made by each student, and the approximate cost of each expressed in the currency of China and England respectively.

A Joiner's Shop.

Special Joiner's shop fitted up to accommodate seven or eight joiners engaged in preparing the woodwork for 100 sets of apparatus, each set including 23 articles, thus totalling 2,300 separate articles. All done as piece-work. In the foreground is seen a Chinese wood-turner at his lathe.



A Wireless Telegraphy Instalment.

For demonstrating purposes, showing Batteries, Induction Coil, Transmitter, Marconi Filing Coherer, Decohering Trembler, Local Battery. Relay, Galvanometer, Electric Bell and Morse Inker; also models of Poldhu and Cape Breton Marconi's stations and sundry diagrams.

List of Apparatus made by Students with Cost Price of each.

		Chinese Cash.	Cash.
1.	Electro Magnet on stand	500	15
2.	Wheatstone's Needle Telegraph ...	250	$7\frac{1}{2}$
3.	Morse Telegraph Instrument... ...	400	12
4.	Galvanometer...	400	12
5.	Electric Bell	400	12
6.	Commutator for Reversing Currents	100	3
7.	Copper Helix to demonstrate Electro Magnetism	300	9
8.	Oersted's Apparatus	150	$4\frac{1}{2}$
9.	,, ,, eopper rectangle and 3 needles	150	$4\frac{1}{2}$
10.	Bell's Telephone Transmitter ...	500	15
11.	Carbon Peneil Microphone	100	3
12.	Swing Board Mierophone	100	2
13.	Carbon Granual Telephone Receiver...	100	3
14.	Resonator Mierophone	100	3
15.	Apparatus to demonstrate Frictional Electricity	150	$4\frac{1}{2}$
16.	Apparatus to demonstrate Conductors and Non-conductors	100	3
17.	Apparatus to demonstrate any two metals produee electricity... ...	300	9
18.	Simple Voltaie Couple	150	$4\frac{1}{2}$
19.	Copper and Zine Gravity Battery ...	500	15
20.	Apparatus to demonstrate Electrolysis of Water	400	12
21.	Electro Magnetie Engine	600	18
22.	Shoeking Coil...	1,000	30
23.	Eleetro Magnetic Needle Telegraph Instrument	200	6
			$208\frac{1}{2}$
			17/$4\frac{1}{2}$d.